Is the tendency to conform influenced by the age of the majority?

Title

‘Is the tendency to conform influenced by the age of the majority?’

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Abstract

The aim of the current study was to explore the influence that the age, and the familiarity, of a group majority has upon copying fidelity in 4- to 6-year-old children. In Experiment 1 participants (N = 120, M age = 68 months) viewed 5 child models, all of whom were either younger, the same age, or older than themselves open a puzzle box using an inefficient (4 models), or an efficient technique (1 model). In Experiment 2 (N = 82, M age = 71 months) the identical task was presented by groups of unfamiliar models. In both Experiments 1 and 2 a group of control participants saw an equal number of inefficient and efficient models. Results showed that the participants displayed conformity irrespective of the age, or the familiarity, of the individuals comprising the majority. However, the participants varied in their level of imitative fidelity depending on the identity of the group majority, with majorities that were either the same age, or considerably older, than the participants eliciting the highest levels of over-imitation. In contrast groups comprising individuals who were younger than the participants elicited a significantly lower level of over-imitation to that elicited by the same aged and older majorities. We suggest that these findings demonstrate an interplay between conformist and model-based transmission biases.

Introduction

If we were to glance around our everyday environments, we would likely see ample evidence of the human disposition to adopt the behaviors and attitudes of those surrounding them. This conformist tendency was demonstrated experimentally by Solomon Asch in the 1950's where a substantial proportion of adult participants were shown to agree with a majority response in a perceptual judgment task despite the majority view being clearly incorrect (Asch, 1955; 1956). This bias to conform- here defined as the propensity to display a behavior as it is the most frequent displayed in others (Claidière & Whiten, 2012)- seems somewhat surprising as it would appear to have the potential to lead individuals, at least on some occasions, to adopt ineffectual responses. However, evolutionary biologists have shown that rather than conformity being a limitation of our species, our bias towards conformity most likely serves key social functions by promoting ingroup cohesion and defining ingroup/outgroup boundaries (Boyd & Richerson, 1988; 2009; Henrich & Boyd, 1998). The potential importance of conformity, both theoretically and behaviorally, has led to recent explorations of the phylogenetic (Haun, Rekers, & Tomasello, 2012), and ontogenetic roots of this conformist disposition (Corriveau & Harris, 2010; Haun & Tomasello, 2011).

Studies that have adapted the Asch paradigm for use with preschool children have shown that 3/4-year-old children conform at similar levels to their adult counterparts when faced with a majority (of adults or peers) making an incorrect perceptual judgement (Corriveau & Harris, 2010; Haun & Tomasello, 2011). Similarly, studies from the trust in testimony literature have shown children's readiness to conform to the label used by the majority even when this label is incorrect (Chen, Corriveau, & Harris, 2012; Fusaro & Harris, 2008, 2013; Seston & Kelemen, 2013). More recently, the study of conformity within the preschool period has been extended to the domain of action copying, with studies asking whether individuals will copy the actions displayed by a majority over an alternative action

displayed by a minority. In one such study 2-year-old humans, orangutans and chimpanzees were allowed to observe a majority of same species models each place a ball in the same container (from a choice of three), whilst a single individual (the minority) was seen to place their ball in a different container (Haun, Rekers & Tomasello, 2012). The results showed that two of the three species were influenced by the majority, with 56% of the children and 72% of the chimpanzees placing their ball in the same container as the majority despite there being no rationale for doing so. The orangutans by contrast responded randomly. Conformity to the actions displayed by the majority has also been demonstrated in slightly older children, with 3- to 6-year-olds more readily performing the technique used to remove pegs from a pegboard by two models, than the same technique performed by a single model (Herrmann, Legare, Harris, & Whitehouse, 2013).

That the children in the studies described above readily adopted the same actions as the majority suggests that the domain of action copying may provide a fruitful, and as of yet relatively untapped, avenue with which to explore conformist behavior. Traditional action copying (social learning) studies are most often dyadic (one model and one observer), and precise fidelity to the task is assessed using a two-action design where half of the participants see a single model operate an object using technique A, with the remaining half viewing a single model operate the same object using an equally effective technique B (e.g., Whiten, Custance, Gomez, Teixidor, & Bard, 1996). Studies have shown that children frequently copy the technique witnessed with high levels of fidelity (e.g., Hopper, Lambeth, Schapiro & Whiten, 2008; Whiten et al., 1996), however we currently know little of how children will respond when viewing a group of models, the majority of whom perform a task using a different technique to a minority. Will children conform to the technique performed by the majority even if there is no need to do so in order to succeed in the task? A tentative answer to this question can be extrapolated from the findings of recent studies that have used an open

diffusion approach to explore the cultural transmission of tool use in preschool children (Flynn & Whiten, 2012; Whiten & Flynn, 2010). In these open diffusion studies an individual who was pre-trained to retrieve a reward from inside a puzzle box, using one of two different, but equally effective, techniques, was allowed to perform the task within their naïve peer group. Typically, the technique seeded spread, with the majority of individuals adopting the technique performed by the pre-trained individual, providing suggestive evidence that preschool children will conform to the most common behavioral variant witnessed. More recent studies that have provided a more direct test of conformity in the context of action copying have shown that children prefer to copy the actions used by a majority (of adult models) than a minority when both solutions are equally successful (Wilks, Collier-Baker, & Nielsen, 2015). A majority preference that occurs independently of emotional reactions to the behavior (Turner, Nielsen, Collier-Baker, 2014). The preference to copy to an adult majority has also been demonstrated in the context of tool selection, where children frequently selected the same inefficient tool chosen by an adult majority rather than an efficient tool chosen by a minority (DiYanni, Corriveau, Kurkul, Nasrini, & Nini, 2015).

The current study aimed to build on previous conformity studies by detailing not only whether the behavior of the majority influences the propensity of 4- to 6-year-old children to conform, but also asks for the first time whether the age of the group majority relative to the observer impacts on this tendency. Previous studies have used either adult models or same aged peers, thus we know little of the relative influence that individuals of different ages have on conformist behavior. This leaves open the question of whether some individuals who are present in an observer's day-to-day environment have a greater influence on copying behavior than others. The task used was the Glass Ceiling Box, first designed for use in a comparative project (Horner & Whiten; 2005), and subsequently adopted by many researchers to explore what has become known as 'over-imitation', or 'over-copying' in both

the preschool period and beyond (e.g., Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons, Young, & Keil, 2007; McGuigan, Gladstone, & Cook, 2012; McGuigan, 2012; 2013; Moraru, Gomez, & McGuigan, 2016; Nielsen & Blank, 2011). In contrast to the traditional two-action design tasks described above, where the model operates the task using only actions that are causally necessary (e.g., removing an obstruction to obtain a reward), the Glass Ceiling Box is modelled using actions that are both causally unnecessary (the lack of causality is evident as the box is transparent) and causally necessary to retrieve a reward. Modelling the task in this way allows observers to approach the task efficiently by retrieving the reward by opening a small door on the front face of a box and inserting a stick tool inside (the efficient task variant). Alternatively observers could over-imitate by performing a number of causally irrelevant actions on the top of the box (e.g., tapping the box with the tool) before reward retrieval occurs (the inefficient task variant).

The majority of the previous studies that have used the Glass Ceiling Box have utilized a single adult model who always demonstrated the task inefficiently (e.g., McGuigan & Whiten, 2009; McGuigan,Whiten, Flynn & Horner, 2007; Whiten, Allan, Devlin, Kseib, Raw, & McGuigan, 2016). Typically children in the age period 3-5 years over-imitate by copying the causally irrelevant actions performed by the adult model with extremely high levels of fidelity (e.g., Lyons et al., 2007; Nielsen & Tomaselli, 2010). The high levels of over-imitation witnessed following task demonstration by an adult model contrast with the findings of studies that have shown that a child model tends to elicit much lower levels of irrelevant action fidelity (Flynn, 2008; McGuigan & Graham, 2010; McGuigan, Makinson, & Whiten, 2011; Wood, Kendal, & Flynn, 2012). However, the results of a recent study suggest that task demonstration by multiple inefficient peers can lead to increased levels of over-imitation (McGuigan & Robertson, 2015). McGuigan and Robertson (2015) asked whether 4-year-old children would switch from their initially efficient approach to the task if the number

of inefficient models were incrementally increased. In an initial phase the children saw two familiar peers perform the task, one efficiently and one inefficiently, before one of the models left the testing room leaving the participant to perform the task in the presence of the remaining model. The results showed that the children always performed the task efficiently irrespective of which model was present during their reproduction. However, in a second phase of the study the same participants became increasingly likely to include the irrelevant actions in their reproductions as the number of familiar peers performing the task inefficiently increased (from 1 to 4 inefficient individuals). The highest levels of over-imitation were witnessed after viewing a 4:1 ratio of inefficient to efficient models, although even a small inefficient majority (2:1) was enough to significantly increase the levels of over-imitation witnessed after viewing one efficient and one inefficient model at baseline. Intriguingly, in a final phase of the study where the task was presented to the children outside of the experimental context the level of over-imitation reduced dramatically suggesting that the participants' causal understanding of the task remained intact, and that social influences lay behind their tendency to over-imitate.

The paradigm used by McGuigan and Robertson (2015) was adapted in the current study in order to determine whether the levels of over-imitation witnessed would vary according to the age of the models comprising the group majority. In McGuigan and Robertson (2015), the group majority comprised familiar individuals who were the same age as the observers, leaving open the question of whether or models who are either younger, or older, than the participants would elicit varying levels of over-imitation. Previous dyadic studies (e.g., Koenig & Harris, 2005; Koenig, Clèment, & Harris, 2004) have pointed to the existence of age related copying biases (e.g., prestige bias; expertise bias), where children show a preference for learning from older informants, and conversely show a distrust of information provided by younger informants (i.e., younger individuals are viewed as less

knowledgeable and less esteemed than older individuals). However, it has yet to be determined whether these biases are evident outside of dyadic contexts.

In order to explore the influence that the age of the majority has on copying fidelity, 4- to 6-year-old participants in Experiment 1 were presented with task solutions by a group of five models (4 inefficient models and 1 efficient model) who were either all younger than the participants, all the same age as the participants, or all older than the participants (as in McGuigan & Robertson 2015 the models (with the exception of the oldest models) attended the same elementary school as the participants). In a second experiment, we explored the influence of model familiarity by presenting the identical task to that used in Experiment 1 to a second group of participants who were unfamiliar with the models. In both Experiments 1 and 2 we included a further test of conformity by allowing each participant to perform the task in a 'post-experiment' trial in which they were led to believe that the experiment was complete, thereby removing the social pressure to conform. We predicted that irrespective of model familiarity the children would be least likely to reproduce the causally irrelevant actions when faced with an inefficient majority younger than themselves, with the tendency towards over-imitation increasing as the age of the models comprising the group majority increased.

Experiment 1

Method

Participants

One hundred and twenty participants (60 males and 60 females) who ranged in age from 54 to 78 months (M = 68 months, SD = 6 months) took part in the study. The children

were allocated to one of 6 conditions each of which comprised 20 participants. In addition to the experimental participants the study required the participation of 32 (16 males and 16 females) pre-trained child models who provided the task demonstrations in each condition. Children were predominantly Caucasian and came from mixed socioeconomic backgrounds. Informed consent was obtained from a parent or guardian of each child.

Design

The participants were randomly allocated to one of six conditions in a between participants design, and their responses videotaped for later analysis. In five 'inefficient majority' conditions the participants viewed a total of five task demonstrations (4 inefficient, 1 efficient) presented by a group of five identically aged models (both male and female) who were either all younger (3-year-old models), all the same age (5-year-old models), or all older than the participants (8-year-old models, 11-year-old models or 13-year-old models). Irrespective of condition, four individuals performed the task inefficiently (the majority), and one individual performed a single efficient demonstration (the minority) with the gender of the efficient model, and the order in which the efficient model demonstrated (1^{st}, 2^{nd}, 3^{rd}, 4^{th} or 5^{th}) fully counterbalanced.

In a 'no-majority' control condition participants viewed two task demonstrations, one performed by an efficient model and one by an inefficient model (both 5 years of age, one male and one female), with the gender and the order in which the efficient and inefficient models demonstrated fully counterbalanced. All of the models were recruited from the same elementary school (and adjoining Kindergarten class) as the participants with the exception of the 13-year-old models who had recently attended the same elementary school as the participants but were now attending a nearby Junior High School. The school environment

was one that allowed for interaction between the youngest and oldest children on a daily basis. However, in order to emphasize that the models were attending the participants' school (or the nearby Junior High) the models were filmed in full school uniform.

Apparatus

The apparatus used was a transparent puzzle box ($20cm^3$) that was completely sealed with the exception of two small openings, one on the top of the box and one on the front face of the box. Each of the openings was covered by a defence, which comprised a small door in the case of the front opening, and two bolts in the case of the top opening. The opening on the front face of the box was connected to an opaque tube that held a reward (a small magnetic toy). In order to retrieve the reward the participant was required to slide open the door and insert a tool (22cm long) with a magnetic tip into the tube. In contrast, the reward could not be retrieved via the opening on top of the box, as a 'false ceiling' prevented the tool from making contact with the tube. Actions directed toward the box could therefore be divided into two distinct types: causally relevant actions (directed to the front face of the box) and causally irrelevant actions (directed to the top of the box).

Procedure

Experimental Phase. On entry to the testing room, the participant was asked to sit at a table directly facing the puzzle box. The experimenter then told the participant that: 'There is a toy inside the box, and I'm going to show you [the participant] a video of some other children getting the toy out' (the same toy was extracted from the box by all models). When the participant appeared comfortable, the box was moved out of direct sight and the video

was shown via a laptop display. The video comprised five segments, each interspersed with a blank screen that showed each of the five models performing the task individually. In order to ensure that the observer's experience, and subsequent performance, was as naturalistic as possible the experimenter never explicitly mentioned the age of the models.

In the 'inefficient-majority' conditions the participants viewed five different models retrieve the reward from inside the box. Of these models four (the majority) performed five causally irrelevant actions using an identical sequence (removing both bolts and tapping on the internal false ceiling three times) before reward retrieval, whereas one model (the minority) used only the causally necessary actions required to retrieve the toy (opening the door and using the tool to retrieve the reward). In the 'no-majority' control condition the video showed two models retrieve the reward from inside the box, one who performed the same sequence of causally irrelevant actions used in the 'inefficient majority' conditions, and one who used only the causally necessary actions required to retrieve the toy. On completion of the task demonstrations, the box was placed in front of the participant with the following instruction: 'Now it's your turn'. In order that the presence of the experimenter would have minimal influence on the participant's performance the experimenter looked away from the child during their response period.

'Post-experiment' phase. After the experimental phase of the study was complete, each participant received a 'post-experimental' trial in which the experimenter acted as though the experiment was complete by thanking the participant, and giving them a small reward for their participation. Once the participant had been thanked for taking part, they were asked if they could 'check that the toy is back in the box for the next participant'. This post-experimental trial was adapted from that used successfully in previous studies (e.g.,

McGuigan et al., 2012; McGuigan et al., 2015), and aimed to determine whether the participants would continue to perform the causally irrelevant actions outside of the experimental context. As in the experimental conditions, the experimenter looked away during the child's attempt. If the levels of over-imitation were substantially lower in the post-experiment trial, then it is likely that any reproduction of the causally irrelevant actions in the experimental phase was due to the influence of the inefficient majority rather than reflecting the participant's private causal knowledge of the task.

Scoring

An 'over-imitation score' was calculated for each participant by totaling the number of irrelevant actions that matched those demonstrated by the inefficient model(s) (i.e., 2 bolt removals and 3 irrelevant tool taps against the false ceiling). The minimum score a participant could receive was 0 indicating that no causally irrelevant actions were performed, with a maximum score of 5 indicating that all elements of the inefficient sequence were reproduced (i.e., the participant performed 2 bolt removals and 3 taps).

Inter-rater reliability.

The data from 15 children representing 13% of the total sample were coded independently by a naïve observer. The ratings showed high concordance suggesting that the coding scheme was highly reliable for the experiment trial (intraclass correlation: $r = .97$, $p < .001$). In the post-experiment trial no intraclass correlations were conducted as the raters matched exactly.

Results

Preliminary analysis. Initial analysis of the data from the five experimental conditions revealed that the level of over-imitation did not vary according to the position of the efficient demonstration (1st, 2nd, 3rd, 4th or 5th), the gender of the observer, or the gender of the efficient model, nor was there an interaction between observer gender and the gender of the minority efficient model. Similarly, in the 'no-majority' control condition neither the order in which the efficient model demonstrated (1st or 2nd), or the gender of the efficient model influenced task fidelity, therefore these factors were excluded from all subsequent analyses. Irrespective of the condition to which the participants were allocated all of the children successfully retrieved the reward from inside the box, therefore the reproduction of the efficient actions are not considered further.

Experimental phase. Of interest in the analysis was: 1) whether the number of children omitting all of the irrelevant actions would differ between the 'inefficient majority' conditions and the 'no-majority' control condition, 2) whether the irrelevant action sequence would be reproduced with higher levels of fidelity in the 'inefficient majority' conditions than the 'no-majority' control condition, 3) whether the level of over-imitation in the 'inefficient-majority' conditions would vary according to model age, and 4) whether over-imitation would be eliminated when the task was presented outside of the experimental context.

Influence of the majority

Omission of the irrelevant actions. In the 'no-majority' control condition, where the children saw two models, one efficient and one inefficient, the majority (12 from 20) of the children acted efficiently and performed no irrelevant actions (see Table 1). This pattern of responding contrasted with the 'inefficient majority' conditions, where after viewing a majority of models performing inefficiently, only very small numbers of children acted efficiently (see Table 1). A chi-square analysis revealed that the number of children who acted efficiently varied significantly across conditions (χ^2 (5) = 26.3, $p < .001$), with follow up chi-square comparisons revealing that significantly fewer children acted efficiently in each of the 'inefficient majority' conditions than in the 'no-majority' control condition (see Table 1). Taken together these findings suggest that viewing a majority of individuals acting inefficiently significantly increased the likelihood that children would include at least some of the irrelevant actions, with an equal number of efficient and inefficient models resulting in participants omitting the irrelevant actions from their reproductions.

---Table 1 about here---

Fidelity of irrelevant action reproduction.. In order to determine whether exposure to a majority of inefficient models influenced the precise level of fidelity with which the irrelevant action sequence was reproduced the participants over-imitation scores were analyzed using a univariate ANOVA with condition (no-majority or majority: 3-, 5-, 8-, 11- or 13-year-old models) as a between participants factor. The ANOVA revealed a significant main effect of condition ($F(5,114) = 10.02$, $p < .001$, $\mu = .31$) with the post hoc Tukey LSD tests revealing that the inefficient majority had a powerful effect on behavior with the children in each of the 'inefficient majority' conditions performing significantly more irrelevant actions than the children in the 'no-majority' control condition ($p < .001$ for each model group). It appeared that the extent to which the majority influenced the level of over-imitation was influenced by the age of the models, with the post hoc tests revealing that

significantly less over-imitation occurred following task demonstration by the youngest models (mean = 2.8) than either the same aged models (mean = 4.05, p = .02), or the oldest models (mean = 4.05, p = .02) who were copied with equally high levels of fidelity (see Fig. 1). No other condition comparisons were significant. A detailed breakdown of the specific irrelevant actions performed (by bolt removals and irrelevant taps) in each condition is provided in SI Table 1.

---Fig 1. About here---

'Post-experiment' comparisons.

Of additional interest was whether the participants would continue to over-imitate outside of the experimental context when all social pressure to adopt the behavior of the majority was removed. A series of planned comparisons on the data from each condition revealed that the number of irrelevant actions performed in the post-experiment trial was substantially reduced from that witnessed in the experimental trial of each 'inefficient-majority' condition (3-year-old models, $t(19) = 5.78$, $p < .001$; 5-year-old models, $t(19) = 9.02$, $p < .001$; 8-year-old models, $t(19) = 5.42$, $p < .001$; 11-year-old models, $t(19) = 7.89$, $p < .001$; 13-year-old models, $t(19) = 10.16$, $p < .001$), as well as from that witnessed in the 'no-majority' control condition ($t(19) = 3.0$, $p = .007$; see Table 2). These findings suggest that the children's causal knowledge of the task was unchanged and they performed the causally irrelevant actions for social reasons. See SI Table 1 for a detailed breakdown of over-imitation by bolt removals and irrelevant taps in the 'post-experiment' trial of each condition.

---Table 2 about here---

Discussion

The results from Experiment 1 suggest that the participants did not copy the different majority groups with equally high levels of fidelity. Instead the children appeared to be copying selectively, with the same aged and the oldest models eliciting the highest levels of fidelity. Interestingly, this over-imitative tendency was equally high in response to both the same aged and the oldest majority groups, and was in each case significantly greater than that elicited by models who were younger than the participants. A possible explanation for this pattern of copying fidelity lies in the level of expertise attributed to majorities of each age, with the youngest children being deemed least expert and therefore less worthy of copying than the oldest (most expert) children. However, counter to our initial predictions the increase in over-imitation did not share a linear relationship with increasing model age. Instead the same aged children, who based on their age alone would have been viewed as one of the least expert model groups, were copied with equally high levels of fidelity as the oldest children. A possible explanation for this non-linear relationship may lie in the familiarity of the models. The models used in Experiment 1 potentially ranged in how familiar they were to the participants, with the same aged models being the most familiar, the oldest models the least familiar, and the remaining models of intermediate familiarity. Previous studies have shown that children prefer to copy individuals who are familiar to them (e.g., Slaughter, Nielsen, & Enchelmaier, 2008), whilst also showing a preference for copying older expert individuals (e.g., McGuigan et al., 2011; Wood et al., 2012), suggesting a possible interaction between familiarity and the age of the model. In order to tease apart the influence of model age and model familiarity, in a second experiment we presented the videos of the model groups used in Experiment 1 to groups of participants who were unfamiliar with the models used in the video clips.

Experiment 2

In Experiment 2, we aimed to explore the importance of model age, and model familiarity, in the conditions where we found the lowest (i.e., 3-year-old models), and highest (i.e., 5- and 13-year-old models), levels of over-imitation in Experiment 1. If high levels of familiarity with the same aged models, combined with a sensitivity to model expertise, explained the pattern of performance witnessed in Experiment 1 then we would predict that the participants in Experiment 2 would: 1) show a reduction in the level of over-imitation in response to the now unfamiliar same aged models, and 2) would continue to copy the youngest and oldest models with the lowest and highest levels of fidelity respectively (albeit at slightly lower levels than Experiment 1 due to the unfamiliar models). This would generate a linear pattern of responding with the youngest models being copied least faithfully, the oldest models most faithfully, with the same age models eliciting a level of over-imitation intermediate to the younger/older models. If however, model familiarity did not influence the pattern of over-imitation witnessed in Experiment 1 then we would predict an identical pattern of responding in Experiment 2 (i.e. equally high levels of over-imitation in the same aged and oldest models groups combined with a significant reduction in over-imitation in the youngest model group).

Experiment 2 also included a new '2:2 no-majority' control condition in which the participants viewed four models (two efficient; two inefficient), rather than two models (one efficient; one inefficient) as presented in the 'no-majority' condition of Experiment 1. We included the new 2:2 control condition to rule out the possibility that the participants in the 'no-majority' condition of Experiment 1 performed significantly fewer irrelevant actions than the participants in the 'inefficient majority' conditions as the result of viewing only a single inefficient model. In addition, the inclusion of two inefficient models made the memory demands more comparable to that witnessed in the 'inefficient majority' conditions as the number of inefficient task demonstrations, and the total number of task demonstrations, were

more closely equated. It was predicted that the participants would perform very few irrelevant actions in the '2:2 no-majority' condition, and that the number of irrelevant actions performed would be substantially reduced to that witnessed in the 'inefficient majority' conditions.

Method

Participants

Eighty-two participants (46 males and 36 females) who ranged in age from 56 to 83 months (M = 71 months, SD = 7 months) took part in the study. The children were allocated to one of 4 conditions; 3-year-old models (N = 21), 5-year-old models (N = 19), 13-year-old models (N = 20), or a 'no-majority' control (N = 22). The models were those employed in the same aged, youngest, and oldest model conditions of Experiment 1. In order to ensure that the models were unfamiliar to the participants all of the children who took part in Exp.2 were recruited from different schools to that used in Exp. 1. All children were Caucasian and came from mixed socioeconomic backgrounds. Informed consent was obtained from a parent or guardian of each child. An additional 4 children were excluded from the study as they either failed to interact with the task (n = 3), or due to experimenter error (n = 1).

Design/Procedure

The participants' in Experiment 2 were allocated, using a between participants design, to one of three 'inefficient majority' conditions (3-year-old models, 5-year-old models, or 13-year-old models) identical to those presented in Experiment 1. However, in contrast to Experiment 1 all of the models who were included in Experiment 2 were unfamiliar to the

participants. An additional group of participants were allocated to the new '2:2 no-majority' control condition in which the participants viewed two efficient models and two inefficient models. To maintain consistency with the 1:1 control condition of Experiment 1, all 4 of the models (two male and two female) were the same age as the participants (5 years of age) and were taken from the same pool of 5-year-old models used in Experiment 1. The gender of the efficient and inefficient models was counterbalanced throughout, and the order in which the four models demonstrated was fully randomized. The responses of all children were videotaped for later analysis

Inter-rater reliability

The data from 10 children representing 12% of the total sample were coded independently by a naïve observer. The ratings showed high concordance suggesting that the coding scheme was highly reliable for the experiment trial (intraclass correlation: $r = .97$, $p < .001$). In the post-experiment trial no intraclass correlations were conducted as the raters matched exactly.

Results

Preliminary analysis. Initial analysis of the data from the experimental conditions revealed that the level of over-imitation did not vary according to the position of the efficient demonstration (1^{st}, 2^{nd}, 3^{rd}, 4^{th} or 5^{th}), the gender of the observer, or the gender of the efficient model, nor was there an interaction between observer gender and the gender of the minority efficient model. Similarly, in the 2:2 control condition the order in which the efficient and inefficient models demonstrated, and the gender of the efficient model had no significant

effect on task fidelity therefore these factors were excluded from all subsequent analyses. Irrespective of the condition to which the participants were allocated all of the children successfully retrieved the reward from inside the box, therefore the reproduction of the efficient actions are not considered further.

Experimental Phase. Of interest in the analysis was: 1) whether the number of children omitting all of the irrelevant actions would differ between the 'inefficient majority' conditions and the '2:2 no-majority' control condition, 2) whether the irrelevant action sequence would be reproduced with higher levels of fidelity in the 'inefficient majority' conditions than the '2:2 no-majority' control condition, 3) whether the age of the inefficient majority influenced the level of over-imitation witnessed, 4) whether the varying degrees of familiarity with the models in the 'inefficient-majority' conditions of Experiments 1 and 2 would influence the level of over-imitation witnessed, 5) whether the inclusion of an additional inefficient model in the '2:2 no-majority' control would lead to higher levels of over-imitation than that witnessed in the 'no-majority' control condition of Experiment 1, and 6) whether over-imitation would be eliminated when the task was presented outside of the experimental context.

Influence of the majority

Omission of the irrelevant actions. In the 'no-majority' control condition, where the children saw four unfamiliar models, two efficient and two inefficient, the majority (16 from 22) of the children acted efficiently and performed no irrelevant actions (see Table 1). As in Exp. 1 this pattern of responding contrasted with the 'inefficient majority' conditions, where

after viewing a majority of unfamiliar models performing inefficiently, smaller numbers of children acted efficiently (see Table 1). A chi-square analysis revealed that the number of children who acted efficiently varied significantly across conditions (χ^2 (3) = 20.5, p < .001), with follow up chi-square comparisons revealing that significantly fewer children acted efficiently in each of the three 'inefficient majority' conditions than in the 'no-majority' control condition (see Table 1). Taken together these findings suggest that viewing only a single inefficient model could not explain the low levels of over-imitation witnessed in the 'no-majority' control condition of Exp. 1. Instead it appears as though viewing a majority of individuals acting inefficiently, irrespective of their familiarity, results in the observer reproducing irrelevant actions.

Fidelity of irrelevant action reproduction. In order to determine whether exposure to a majority of unfamiliar inefficient models influenced the precise level of fidelity with which the irrelevant action sequence was reproduced the participants over-imitation scores were analyzed using a univariate ANOVA with condition (no-majority or majority: 3-, 5-, or 13-year-old models) as a between participants factor. The ANOVA revealed a significant main effect of condition ($F(2,78) = 10.28$, $p < .001$, $\mu = .28$), with the post hoc Tukey LSD tests revealing that the inefficient majority had a powerful effect on behavior with the children in each of the 'inefficient majority' conditions performing significantly more irrelevant actions than the children in the 'no-majority' control condition ($p = .028$ for the 3-year-old models, and $p < .001$ for the 8- and 13-year-old models; see Fig. 2). It appeared that the extent to which the majority influenced the level of over-imitation was influenced by the age of the models, with the post hoc Tukey LSD tests revealing that significantly less over-imitation occurred following task demonstration by the youngest models ($M = 2.0$) than the oldest models ($M = 3.65$, $p = .005$), with the difference between the same aged ($M = 3.05$) and youngest models approaching significance ($p = .07$; see Fig. 2). No significant difference in

the level of over-imitation was revealed between the same aged models and the oldest models ($p = .35$), with the reproduction of irrelevant actions being relatively high in both groups. See SI Table 1 for a detailed breakdown of over-imitation by bolt removals and irrelevant taps in the experimental trial of each 'inefficient majority' condition.

---Fig 2. About here---

Influence of model familiarity.

In order to determine whether model familiarity influenced the occurrence of over-imitation, the number of irrelevant actions performed in each 'inefficient majority' condition of Experiment 2 was directly compared to the equivalent condition of Experiment 1. The analyses revealed that model familiarity had little influence on imitative fidelity with the number of irrelevant actions performed in the 'inefficient majority' conditions of Experiment 2 not differing significantly from that witnessed in the equivalent condition of Experiment 1 in either the younger model condition (M Exp. 1 = 2.8, M Exp. 2 = 2.0; $t(39) = 1.29$, $p = .20$), or the older model condition (M Exp. 1 = 4.1, M Exp. 2 = 3.7; $t(38) = .76$, $p = .45$), although the analysis of the same aged model condition did reveal a non-significant trend towards higher fidelity copying of familiar models (M Exp. 1 = 4.1, M Exp. 2 = 3.1; $t(37) = 1.76$, $p = .09$). Similarly, performance in the 'no-majority' control conditions did not differ significantly between experiments (M Exp. 1 = 0.9, M Exp. 2 = 0.7; $t(40) = .42$, $p = .68$), suggesting that neither model familiarity, nor the number of inefficient models witnessed influenced the performance of the control children.

The lack of difference between the equivalent conditions of Experiments 1 and 2 suggests that model familiarity had little influence within each individual model group. However, it appeared as though the level of over-imitation was consistently lower across the unfamiliar model conditions than that witnessed in the familiar model conditions. In order to

522 determine whether these differences were significant we collapsed the data from each
523 condition (3-, 5-, and 13-year-old 'inefficient majority' conditions and '2:2 no-majority'
524 control) of Experiment 2 into an unfamiliar model variable and the equivalent four conditions
525 of Experiment 1 into an familiar model variable. A univariate ANOVA with familiarity
526 (familiar or unfamiliar) as a between participants factor revealed that model familiarity
527 influenced the copying fidelity witnessed with significantly fewer irrelevant actions ($F(1,160)$
528 $= 3.96$, $p = .04$, $\mu = .02$) being performed across the unfamiliar model conditions ($M = 2.3$)
529 than the familiar model conditions ($M = 3.0$).

530

531 *'Post-experiment' comparisons.*

532 Of additional interest was whether the participants would continue to over-imitate
533 outside of the experimental context when all social pressure to adopt the behavior of the
534 majority was removed. A series of planned comparisons on the data from each condition
535 revealed that the number of irrelevant actions performed in the post-experiment trial was
536 substantially reduced from that witnessed in the experimental trial of each 'inefficient-
537 majority' condition (3-year-old models, $t(20) = 4.33$, $p < .001$; 5-year-old models, $t(17) =$
538 5.81, $p < .001$; 13-year-old models, $t(19) = 7.89$, $p < .001$; see Table 2), as well as from that
539 witnessed in the 'no-majority' control condition ($t(21) = 2.59$, $p = .017$). These findings
540 suggest that the children's causal knowledge of the task was unchanged, and they performed
541 the causally irrelevant actions for social reasons. See SI Table 1 for a detailed breakdown of
542 over-imitation by bolt removals and irrelevant taps in the 'post-experiment' trial of each
543 condition.

544

Discussion

The results of Experiment 2 show that additional groups of participants over-imitated at similar levels to those participants in the equivalent 'inefficient majority' conditions of Experiment 1. This suggests that high levels of familiarity with the same aged models, in combination with a preference for copying older, more expert models, could not account for the pattern of performance witnessed in Experiment 1. Instead, the consistent level of over-imitation across the equivalent conditions of the two experiments suggests that same aged, and older models, are particularly powerful in eliciting of copying behavior, whereas younger models do not elicit as strong an imitative tendency. In contrast to the high levels of over-imitation witnessed in the 'inefficient majority' conditions the children in the 'no-majority' control conditions of both experiments performed very few irrelevant actions. The equivalence between the two control conditions suggests that viewing only a single inefficient model in the 'no-majority' condition of Experiment 1, and therefore differential memory demands, could not account for the low levels of over-imitation witnessed, instead it appeared as though presenting an equal number of inefficient and efficient models reduced the occurrence of over-imitation from the majority conditions irrespective of whether 1 or 2 inefficient models were viewed.

General Discussion

Taken together the findings of Experiments 1 and 2 show that witnessing task demonstration by a majority comprised of inefficient models resulted in significantly higher levels of over-imitation than viewing an equal number of inefficient and efficient models. However, the extent to which the children in Experiment 1 over-imitated was influenced by the identity of the models comprising the group majority, with children copying the causally

irrelevant actions performed by the same aged models, and the oldest models at equally high levels, a level of copying fidelity that was significantly greater than that elicited by the youngest models. Experiment 2 demonstrated that the pattern of over-imitation witnessed across the different majority groups of Experiment 1did not result from model familiarity, although the inclusion of unfamiliar models depressed the overall level of over-imitation across groups. Intriguingly, in both experiments the reproduction of causally irrelevant actions was almost completely eradicated outside of the experimental context, suggesting that a social motivation may lie behind this conformist tendency. These results integrate the conformity, action copying, and selective action copying literatures in a novel way, and provide detailed insights of the influence of the age, and familiarity, of the majority on children's behavior within the context of over-imitation.

The tendency of the children in the current study to adopt the behavior of the majority is consistent with the findings of previous studies that have shown conformity in the preschool period (Corriveau & Harris, 2010; Haun et al., 2012; Haun & Tomasello, 2011; Herrmann et al., 2013). However, the present findings go beyond showing a conformist bias, to demonstrate that the level of conformity was influenced by the identity of the individuals comprising the majority, with same aged and much older models eliciting high levels of copying fidelity, and younger models failing to elicit equivalent levels of matching behavior. This pattern of performance suggests that whether or not children will conform does not share a straightforward relationship with the number of models displaying a particular task solution. Instead, it appears that children take into account characteristics of the individuals comprising the majority, in this case age, and at a broader level familiarity, before copying selectively. In many respects the selective over-imitation witnessed with differently aged models broadly mirrors that of earlier dyadic studies that have shown that children are more likely to copy the irrelevant actions performed by a single adult model, but not those

performed by a single child model (Flynn, 2008; McGuigan & Graham, 2010; McGuigan et al., 2011; Wood, Kendal, & Flynn, 2013). However, even the youngest majority group in the current study elicited over-imitation at a much higher rate than the single inefficient child model in the dyadic studies, suggesting that copying the majority likely serves an adaptive function (Boyd & Richerson, 1988; Henrich & Boyd, 1998).

As well as the level of over-imitation differing between dyadic and group contexts the children in the current study failed to perform the irrelevant actions in the post-experiment trial. Taken together these findings appear to suggest that the participants' motivations were social in nature (Užgiris, 1981), perhaps resulting from normative conformity (Campbell & Fairey, 1989; Claidière & Whiten, 2012; Deutsch & Gerard, 1955; Tanford & Penrod, 1984), rather than an alteration in their causal knowledge (see Kenward, Karlsson, & Persson, 2011; Kenward, 2012; Keupp, Behne, & Rakoczy, 2013 for a more detailed discussion of the role of normativity in over-imitation). This finding is consistent with the results of previous conformity studies where children's public responses (verbal) were more likely to coincide with the majority than their private responses (pointing) (Haun & Tomasello, 2011). It is also consistent with the finding that preschool children correctly applied perceptual knowledge to a practical problem, despite having earlier gone along with the incorrect majority in an equivalent perceptual judgment task (Corriveau & Harris, 2010). These results suggest that, similar to adults in the pioneering Asch paradigms, children's responses to the majority are fleeting rather than reflecting a permanent change in their knowledge, a process that Corriveau and Harris (2010) termed "respectful deference".

The ability of children to selectively switch their approach between the experimental and non-experimental contexts is consistent with the findings from recent studies that have shown that children readily act on contextual cues provided by the model(s), both social (e.g., number of models performing an action), and verbal (e.g., "she always does it this way"), in

order to appropriately adopt either an informational (instrumental) or a normative (conventional) stance when performing the task (Clegg & Legare, 2016; Legare, Wen, Herrmann & Whitehouse, 2015; Keupp, Bancken, Schillmöller, Rakoczy, & Behne, 2016; Moraru et al., 2016). This capacity for selective copying has recently been extended to situations in which the context switches between normative and instrumental (Keupp, Behne, Zachow, Kasbohm, & Rakoczy, 2015). Underpinning this selective social learning may be transmission biases, a set of evolved cognitive heuristics that enable social learners to respond to their environment adaptively (Boyd & Richerson, 2005). Evolutionary theory suggests that a naïve individual is well served by copying the most prevalent behavior performed by those around them (Boyd & Richerson, 1988; Henrich & Boyd, 1998). This 'copy the majority' approach is useful as the behavior of the majority likely provides information as to what is the most adaptive behavioral variant in that environment, a mechanism that Boyd and Richerson (2005) termed a conformist bias. However, as well as being influenced by the behavior of the majority observers may also be influenced by characteristics of the models, including similarity, prestige and/or expertise relative to the observer (Haun, van Leeuwen, & Edelson, 2013). These model-based biases are likely highly adaptive as they allow individuals to adopt the behaviors utilized by successful individuals, that by extension might ultimately lead to success for the observer themselves (Boyd & Richerson, 2005).

A key aim of the current study was to bring together conformist and model based transmission biases in order to explore the interaction between the two. The results suggest that these biases may interact, with children demonstrating a general tendency to conform to the majority behavior, but the extent to which they do so varying according to age of the individuals comprising the majority, and more broadly model familiarity. Intriguingly, there was not a straightforward relationship between model age and over-imitation with children

copying both same aged models, and much older models, with the highest levels of fidelity. It may be that these model based differences reflect a tendency of children to adopt different biases depending on the age of the majority, with children copying the same aged majority as they were most similar to themselves i.e., a similarity bias. In contrast, a preference for the oldest models, and conversely a lack of preference for the younger models, may have stemmed from an expertise or a prestige bias (where younger individuals are viewed as less expert and less prestigious than older individuals). Indeed previous studies have shown that children in this age period are generally very adept at recognizing expert over inexpert individuals, and acting on that information, in both the domains of action copying (Scofield, Gilpin, Pierucci, & Morgan, 2013), and testimony (e.g., Koenig & Harris, 2005; Koenig, Clément, & Harris, 2004; Pasquini, Corriveau, Koenig, & Harris, 2007).

With respect to the familiarity of the models, the results of Experiment 2 suggest that viewing unfamiliar models depressed the overall levels of over-imitation witnessed across conditions, but did not change the overall pattern of over-imitation witnessed across the different model groups. The higher levels of over-imitation following task demonstration by the familiar models may have resulted from the participants viewing models who were currently, or had recently, attended the same school as the participants, as an ingroup who were more similar to themselves, than the unfamiliar (outgroup) models. However, selectivity based on model familiarity was independent of the age of the majority suggesting that some level of familiarity with the models at the broadest ingroup level (i.e., the same school), may have been enough to elicit a stronger bias to conform than an unfamiliar outgroup. Future studies could usefully explore the way that different transmission biases, both conformist and model based, interact in order to ascertain the conditions under which conformity will occur.

A further feature of the current study that could be usefully examined in future research is the influence that the physical presence of the majority has on the subsequent

behavior of the observer. In the current study, and in the majority of conformity studies involving child participants, the behavior of the majority was presented via a televised display, and the models were not present during the participant's reproduction (e.g., Corriveau & Harris, 2010; Herrman et al., 2013; McGuigan & Stevenson, 2016). As young children frequently copy the majority despite such models not being physically present, it appears that merely viewing the behavior of other individuals is enough to elicit conformist behavior; direct social appraisal or social pressure is not necessary. The lack of influence of model presence contrasts with the findings of Nielsen and Blank (2011) who found that children preferentially copied the technique of a model who remained with them during testing, rather than the technique used by a model who left the testing area. One possible reason for these discrepant findings is that Nielsen and Blank (2011) employed adult models who due to their greater status may lead the children to feel that they 'should' copy the adults approach. Intriguingly, using an almost identical paradigm to that used in the current study McGuigan et al. (2012) found that adults were equally likely to copy an inefficient majority, irrespective of whether the majority were present or absent during the participant's attempt, suggesting that model presence had little influence on copying fidelity. Taken together, these results suggest that both children and adults can use the frequency of individuals displaying a particular task solution as a cue to the behavior that is normative for that particular group. In addition, it appears as though both children and adults are highly sensitive to the context in which the task was presented- conforming in the experimental context when the task presentation was framed as 'your turn', and omitting the irrelevant actions post experiment. It is likely that 'having a turn' directly after viewing the performance of a group engenders a sense of normativity missing in the post experiment presentation. Future studies could usefully explore how sensitive children are to such contextual differences, asking under what conditions children will conform to the majority behavior.

In sum, the current study provides unique insights into the study of conformist behavior in the relatively unexplored area of action copying by showing that, not only were our young children highly conformist, the extent to which children conformed varied according to the identity of the individuals comprising the majority, with same aged and much older models eliciting precise matching, a tendency that was significantly greater than that elicited by models younger than the participants. The familiarity of the models did not influence the overall pattern of copying witnessed, but did reduce the overall level of copying fidelity across conditions. These findings suggest that the interplay between conformist transmission and model-based biases is complex, but is likely a powerful force behind human cultural learning.

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